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XXIII. *Account of the Organ of Hearing in Fish.**By John Hunter, Esq. F. R. S.*

Read Nov. 14, 1782.

NATURAL history has ever been considered as worthy the attention of the curious philosopher, and therefore has in all ages kept pace with the other branches of knowledge; and as both arts and sciences have, of late years, been cultivated to a degree, perhaps, beyond what was ever known before, we find also, that natural history has not been neglected; all Europe appears to be awake to it. In this island it has been pursued with more philosophic ardour, than what was ever known in any country. It has become the study of men of independent fortunes, who not only spend their fortunes in the cultivation of this science, but have risked their health and lives in pursuit of it, searching unknown regions to improve mankind, settling correspondences every where, so as to bring in its materials into this country, in order to make it the school of natural history. It is no wonder, then, that a spirit of inquiry is diffused through almost all ranks of men; and that though many cannot pursue it themselves, yet they are eager to know what is already known, chusing at least to benefit by the industry of others.

These reflections have induced me to trouble this learned Society with a short account of the Organ of Hearing in

Fish, it being still a subject of great dispute, whether fish hear or not.

Some time between the years 1750 and 1760, I observed the organ of hearing in fish; and from that time to this, I only considered it as a link in the chain of the varieties in this sense in different animals, in which there is a regular progression, *viz.* from the most perfect animals down to the most imperfect possessed of this organ *.

As I do not intend to give, in this paper, a full account of this organ in any one fish, or of the varieties in different fish, but only of the organ in general; those who may chuse to pursue this part only of the animal œconomy may think it deficient in the descriptive parts. If it was a difficult task to expose this organ in fish, I should perhaps be led to be more full in my description of it, but there is nothing more easy than the exposure of this organ in this animal in general.

As this paper is to be confined to this order of animals, I may be allowed just to observe here, that the class called sepia has this organ also, but somewhat differently constructed from what it is in the fish.

The organs of hearing in this latter order of animals are placed on the sides of the skull, or that cavity which contains the brain; but the skull itself makes no part of the organ, as it does in the quadruped and the bird. In some fish this organ is wholly surrounded by the parts composing this cavity, which in many is cartilaginous, the skeleton of these fish being

* Preparations to illustrate these facts have been ever since shewn in my collection to the curious both of this country and foreigners: when in shewing whatever was new, or supposed to be new, the ears of fish were always considered by me as one important article.

like those of the ray kind; in others also, as in cod, salmon, &c. whose skeleton is bone, yet this part is cartilaginous.

In some fish this organ is in part within the cavity of the skull, or that cavity which also contains the brain, as in the salmon, cod, &c. the cavity of the skull projecting laterally, and forming a cavity there.

The organ of hearing in fish appears to grow in size with the animal, for its size is nearly in the same proportion with the size of the animal, which is not the case with the quadruped, &c. the organs being in them nearly as large in the growing foetus as in the adult.

It is much more simple in fish than in all those orders of animals who may be reckoned superior, such as quadrupeds, birds, and amphibious animals, but there is a regular gradation from the first to fish.

It varies in different orders of fish; but in all it consists of three curved tubes, all of which unite with one another; this union forms in some only a canal, as in the cod, salmon, ling, &c.; and in others, a pretty large cavity as in the ray kind. In the jack there is an oblong bag, or blind process, which is an addition to those canals, and which communicates with them at their union. In the cod, &c. this union of the three tubes stands upon an oval cavity, and in the jack there are two of those cavities; these additional cavities in these fish appear to answer the same purpose with the cavity in the ray or cartilaginous fish, which is the union of the three canals.

The whole is composed of a kind of cartilaginous substance, very hard or firm in some parts, and which in some fish is cruusted over with a thin bony lamella, so as not to allow them to collapse; for as the skull does not form any part of

those canals or cavities they must be composed of such substance as is capable of keeping its form.

Each tube describes more than a semi-circle. This resembles in some respect what we find in most other animals, but differs in the parts being distinct from the skull *.

Two of the semi-circular canals are similar to one another, may be called a pair, and are placed perpendicularly; the third is not so long; in some it is placed horizontally, uniting as it were the other two at their ends or terminations. In the skait it is something different, being only united to one of the perpendiculars.

The two perpendiculars unite at one part in one canal, by one arm of each uniting, while the other two arms or horns have no connection with each other, and the arms of the horizontal unite with the other two arms of the perpendicular near the entrance into the common canal or cavity.

Near the union of those canals into the common, they are swelled out into round bags, becoming there much larger.

In the ray kind they all terminate in one cavity, as has been observed; and in the cod they terminate in one canal, which in these fish is placed upon the additional cavity or cavities. In this cavity or cavities there is a bone or bones. In some there are two bones; as the jack has two cavities, we find in one of those cavities two bones, and in the other only one; in the ray there is only a chalky substance †.

At this union of the two perpendiculars in some fish enters the external communication, or what may be called the external meatus. This is the case with all the ray kind, the external orifice

* The turtle and the crocodile have a structure somewhat similar to this; and the intention is the same, for their skulls make no part of the organ.

† This chalky substance is also found in the ears of amphibious animals.

of which is small, and placed on the upper flat surface of the head; but it is not every genus or species of fish that has the external opening.

The nerves of the ear pass outwards from the brain, and appear to terminate at once on the external surface of the swelling of the semi-circular tubes above described. They do not appear to pass through those tubes so as to get on the inside, as is supposed to be the case in quadrupeds; I should therefore very much suspect, that the lining of those tubes in the quadruped is not nerve, but a kind of internal periosteum.

As it is evident that fish possess the organ of hearing, it becomes unnecessary to make or relate any experiment made with live fish which only tends to prove this fact; but I will mention one experiment, to shew that sounds affect them much, and is one of their guards, as it is in other animals. In the year 1762, when I was in Portugal, I observed in a nobleman's garden, near Lisbon, a small fish-pond, full of different kinds of fish. Its bottom was level with the ground, and was made by forming a bank all round. There was a shrubbery close to it. Whilst I was laying on the bank, observing the fish swimming about, I desired a gentleman, who was with me, to take a loaded gun, and go behind the shrubs and fire it. The reason for going behind the shrubs was, that there might not be the least reflection of light. The instant the report was made, the fish appeared to be all of one mind, for they vanished instantaneously into the mud at the bottom, raising as it were a cloud of mud. In about five minutes after they began to appear, till the whole came forth again.

